

## PM Test Methods Comparison For Stationary Diesel Engines

August 26, 2003



California Environmental Protection Agency  
Air Resources Board

### Stationary Diesel Engine PM Test Method Comparison

## Test Method Working Group

- Background / Issues
- Overview of Test Methods
- Results
- Next Steps
- Conclusions
- Recommendations



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## **Background**

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- **Lack of correlation between the two methods**
  - ◆ ISO 8178 used for verification and EPA certification
  - ◆ Method 5/100 used for permitting and compliance
- **Variations in results between methods may**
  - ◆ Impact product verification
  - ◆ Source compliance evaluations

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## **Issues**

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- **CARB Method 5 Issues**
  - ◆ Potential method bias and artifact formation (primarily with impinger catch)
  - ◆ Controlled emissions levels may be below detection limit
  - ◆ Expensive and difficult to perform in field
- **ISO 8178 Issues**
  - ◆ Limited field availability
  - ◆ Expensive to perform in field
  - ◆ No ambient temperature condensable PM component

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## Test Method Comparison

- Method comparison tests on six engines
  - ◆ Direct comparisons CARB M5 / ISO 8178
  - ◆ Testing at 50%, 75% and 100% loads (D1 cycle)
  - ◆ Triplicate samples for each load
- Sample characterization-selected M5 tests
- PM minidilution testing in selected engine tests

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## Field Testing

Make/Model	Emission Controls	Description 100 % load	Fuel Sulfur (ppm)
Detroit Diesel 8V-92 1991 (Bug 2)	Uncontrolled	2 Stroke 469 Hp	374 ppm
Cat 3406B 1991 (Bug 3)	Uncontrolled	4 Stroke 422 Hp	90 ppm
Detroit Diesel Series 60 1999 (12.7l) (Bug 6)	Uncontrolled	4 Stroke 402 Hp	144 ppm
Cat 3406 C 2000 (Bug 13)	Uncontrolled	4 Stroke	CARB
Cat 3406C 2000 (Bug 13)	Passive DPF	4 Stroke	ULSD (<15ppm)
Detroit Diesel Pre 87 (Bug 14)	DOC Fuel Additive	2 Stroke	ULSD

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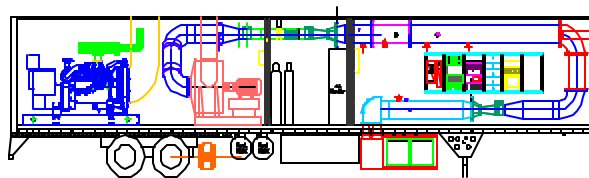
## Test Methods Overview

CARB Method 5	ISO 8178
Standard Stationary Engine Test Method	Standard Method for Certification and Verification
Raw Exhaust	Diluted
Filter 248±25 °F (120±14 °C) Impinger (~60 °F)	Filter Below 125°F (52 °C) No Impinger
Field Available	Laboratory Availability Limited Field Availability
Method does not define test loads or speeds	Method defines engine test loads and speeds

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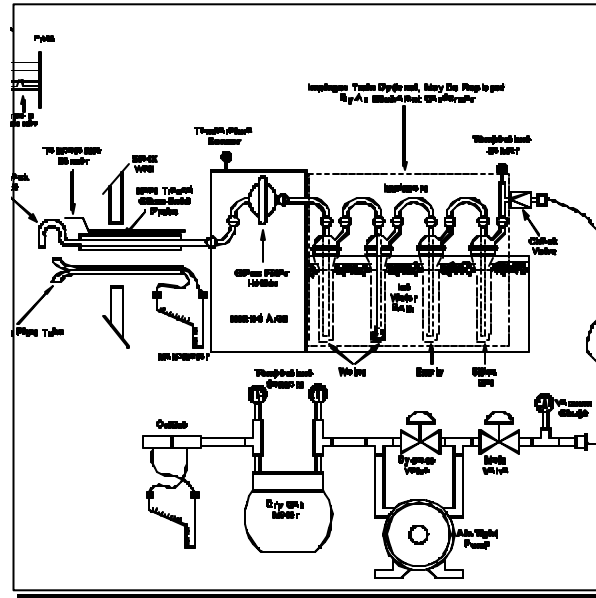
## CE-CERT's HDD Mobile Lab

### CVS Full-Flow Dilution Emission Testing



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## Method 5 Schematic



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### Stationary Diesel Engine PM Test Method Comparison

#### D1 Cycle Weighted Emission Factors

Mode i	1	2	3
Load	100%	75%	50%
Weighting factor	0.3	0.5	0.2

$$D1 E_f = \frac{0.3( PM_{100\%} ) + 0.5( PM_{75\%} ) + 0.2( PM_{50\%} )}{0.3( Hp_{100\%} ) + 0.5( Hp_{75\%} ) + 0.2( Hp_{50\%} )}$$

Where:

PM is particulate mass per time at given mode in gm/hr

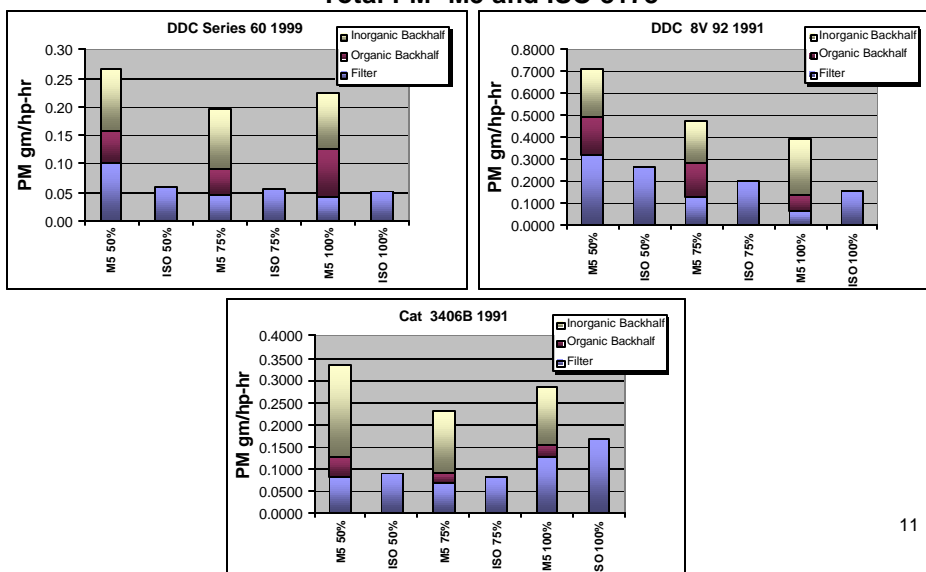
Hp is load at given mode

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## Stationary Diesel Engine PM Test Method Comparison

### Baseline Comparisons

#### Total PM- M5 and ISO 8178

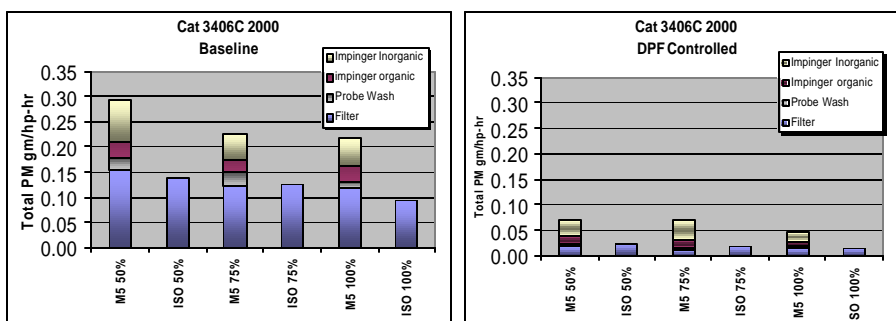


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## Stationary Diesel Engine PM Test Method Comparison

### Baseline and Controlled

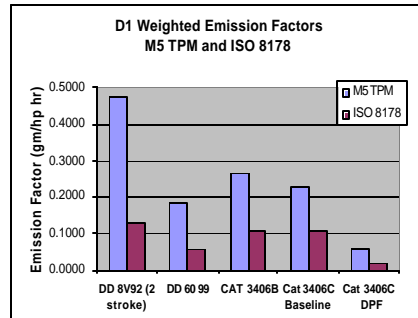
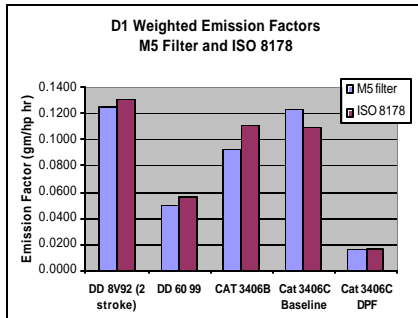
#### Total PM- M5 and ISO 8178



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## Stationary Diesel Engine PM Test Method Comparison

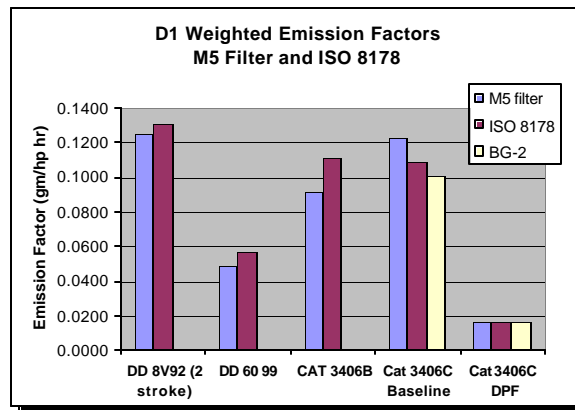
### D2 Weighted PM Emission Factor Comparisons M5 and ISO 8178



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## Stationary Diesel Engine PM Test Method Comparison

### D2 Weighted PM Emission Factor Comparisons M5, ISO 8178 and Minidilution



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## Conclusions

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- **Good Agreement Between CARB M5 Filterable, ISO 8178 Full-Flow & Minidilution**
  - ◆ PM
  - ◆ Control Efficiency-% Reductions
- **CARB M5 total PM 2 to 4 times higher than ISO 8178**
- **Control Efficiency lower with CARB M5 Total PM**

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## Next Steps

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- **Meet with Test Method Working Group**
- **Present Final Recommendations to Key Stakeholders**
- **Incorporate into Proposed ATCM**

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